Space Weather Technical Forecast

Issued on Friday 29 November 2024 at 01:07 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Low to Moderate Activity expected. CME arrival Day 1 (29 Nov) with potential for G1-G2/Minor to Moderate Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the past 24 hours, with only C-class activity observed. There are nine active regions currently on the Earth-facing disc. The largest of these remain AR3905 and AR3906 in the southwest, with some interaction likely between the two regions, however they have remained relatively inactive. A new region emerging into the southeast has been numbered as AR3912, and may be one region or two separate regions - for the time being it is classified as one region but this may change as it moves into a clearer viewing angle. The remaining regions are generally smaller and simpler, with no sign of notable growth or development.

A partial filament eruption was observed occurring in the southeast quadrant, starting around 28/0428 UTC. The accompanying CME has been analysed, and while most of the material misses Earth there is a chance of a slight impact on the 2nd December.

Solar Wind / Geomagnetic Activity: Solar winds, measured by ACE and DSCOVR at L1, were at background levels generally around 350km/s with density around or below average. Interplanetary Magnetic Field, Bt, was mostly weak, just peaking at 8nT. The north-south component, Bz, varied weakly between +/-5nT. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels. The associated 24-hour fluence remained well below the Active threshold. The integrated flux observed at 29/0000 UTC was 1.32e6 total pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a chance of isolated M-class flares, and a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: A CME from the filament eruption on 25 Nov is expected to arrive early today (29 Nov), but with the bulk of its material passing south and east. Otherwise, mainly background winds are expected until day 4 (2nd Dec) when there is a possibility of a

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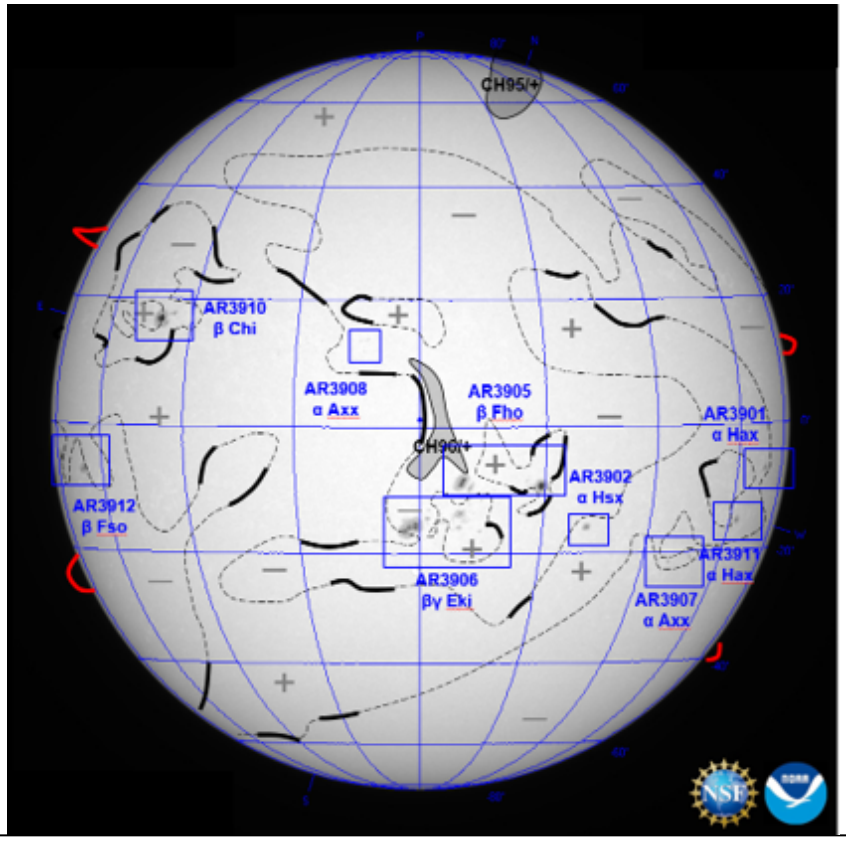
glancing blow from a CME which left the Sun about 28/0430UTC. Initial Quiet (Kp 0-2) geomagnetic activity is likely to increase Active to G1/Minor Storms (Kp 4-5) for a while today, due to a CME arrival. There is slight chance of G2/Moderate Storms (Kp 6). CME enhancements then ease later today with Quiet to Unsettled (Kp 1-3) conditions following for the remainder of the forecast period, although there is a chance of a glancing blow CME arrival through day 4 (2nd Dec) temporarily increasing activity to Unsettled to Active (Kp 3-4).

Energetic Particles / Solar Radiation: High energy protons are expected to persist at background levels but with a slight chance of rising in response to any notable flares. High energy electron flux is expected to persist at mainly background levels with the associated 24 hour fluence remaining below the Active threshold.

Figure 1: Synoptic map valid 28/1924 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are a couple of CMEs of interest. The most notable is from the filament eruption around 25/2030 UTC. The majority of the ejecta is directed south and east, however a partial halo shock component is also evident. There is a moderate confidence for at least a glancing impact early today (29 Nov). However, the timing of this is low confidence due to MOSWOC Enlil currently providing poor guidance as it is significantly over-estimating the current wind speeds. Solar Orbiter, which is currently between Earth and the Sun, registered the CME arrival around 28/1100 UTC. with the Bt increasing to 15 nT. Therefore the CME is still expected to arrive at Earth.

The second CME, due to a filament eruption from the southeast disc around 28/0428 UTC, has now been analysed. This is slow and mostly travelling below Earth's orbit, but may give a glance a end of this period, on 02 Dec. It is likely to be quite weak by that time, however.

While a number of other CMEs have been observed on previous days these are either missing Earth, or are narrow, slow and expected to give minimal impacts given their trajectory. No coronal hole fast winds are expected during this period.

Initial Quiet (Kp 0-2) geomagnetic activity is likely to increase Active to G1/Minor Storms (Kp 4-5) for a while today, if any prolonged negative (southward) orientated north-south component of the IMF is observed with any magnetic cloud that follows the CME arrival. There is slight chance of G2/Moderate Storms (Kp 6). CME enhancements then ease later today with Quiet to Unsettled (Kp 1-3) conditions following for the remainder of the forecast period, although there is a chance of a glancing blow CME arrival through day 4 (2nd Dec) temporarily increasing activity to Unsettled to Active (Kp 3-4).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	50	10	1	20
Strong	**G3**	No	1	1	1	0
Severe	**G4**	No	1	1	1	0
Extreme	**G5**	No	1	1	1	0

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
25/11/2024 20:30	Partial	AR3901	SE	950	28/11/2024 07:00 UTC	More likely to be later than original forecast.
28/11/2024 04:28	Partial	Filament	SE	390	02/12/2024 12:00 UTC	Low confidence glancing blow.

Figure 2: MOSWOC Enlil

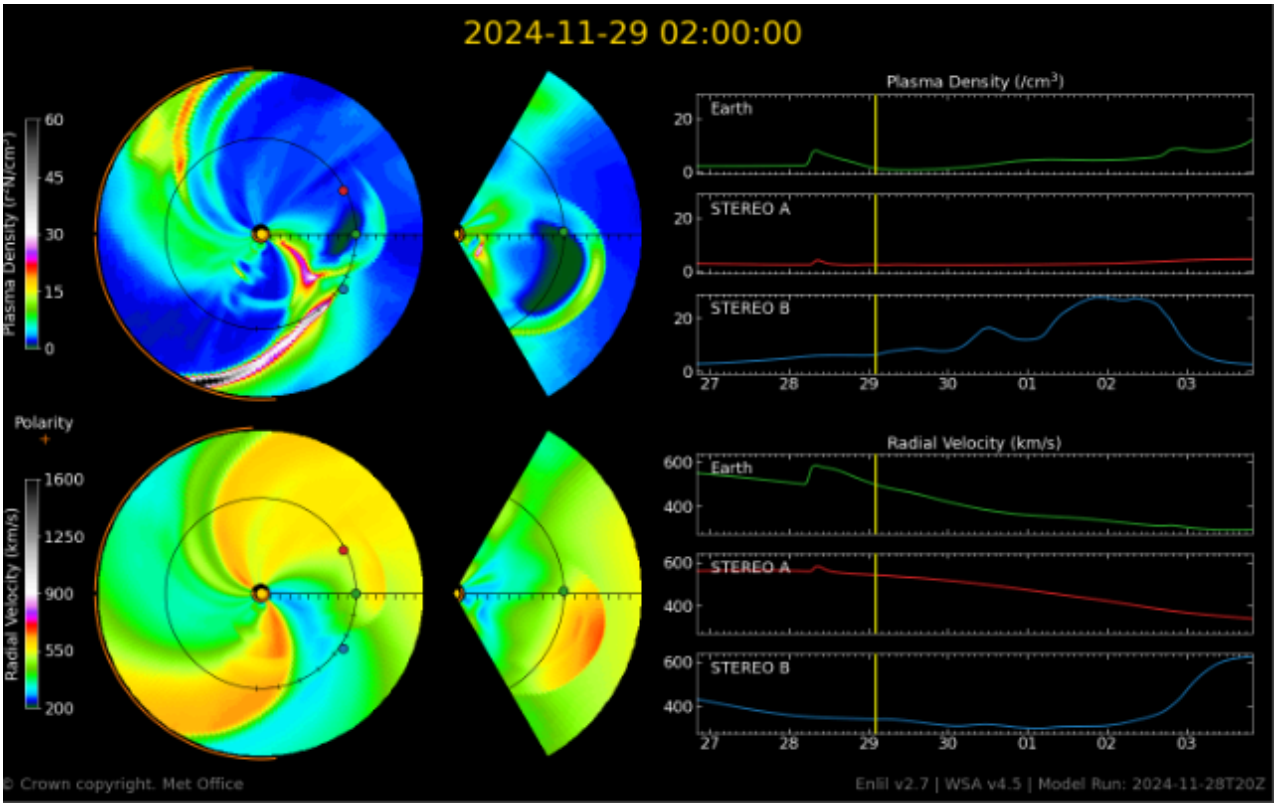

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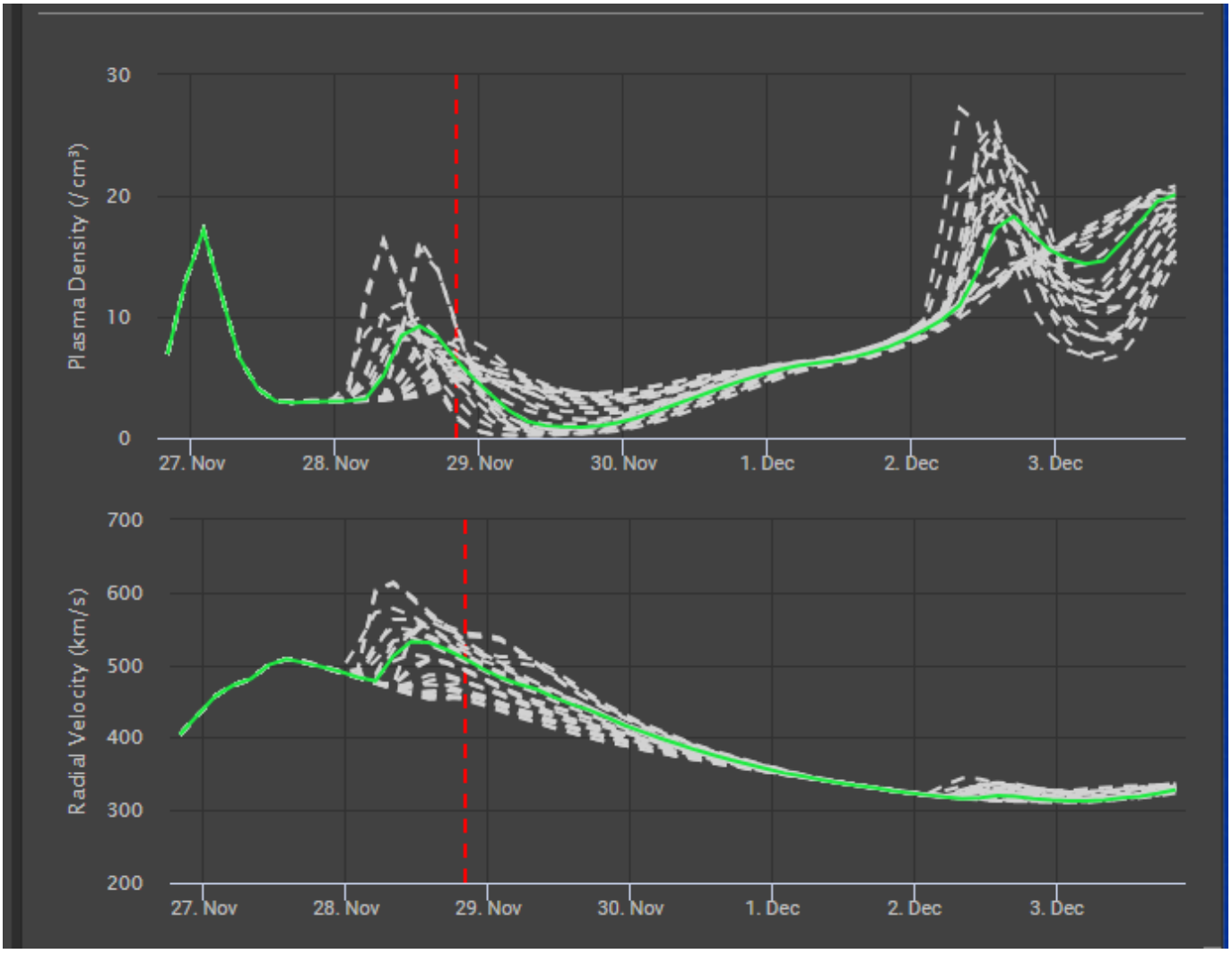
Figure 3: MOSWOC Enlil Ensemble



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Radio Blackouts - X-Ray Flares

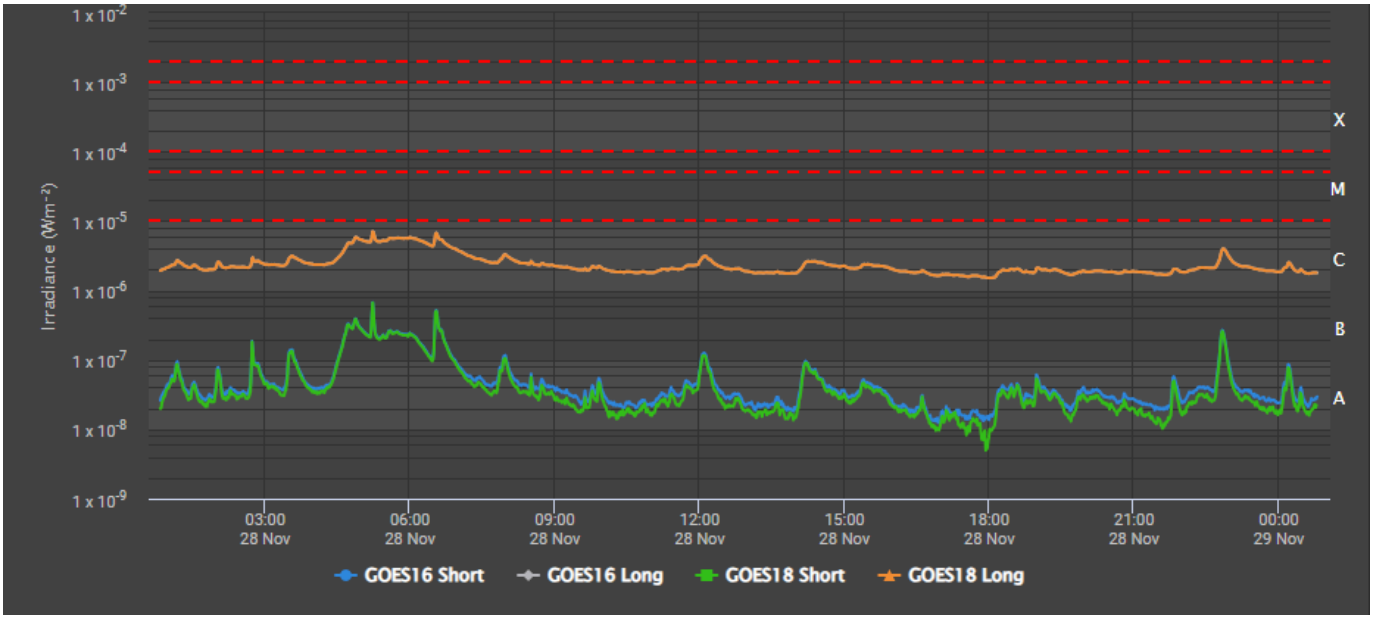
Low to Moderate activity is expected with a chance of isolated M-class flares, and a slight chance of X-class flares.

There are nine active regions currently on the Earth-facing disc, including recently numbered AR3912. The largest of these remain AR3905 and AR3906 in the southwest, with some interaction likely between the two regions, however they have remained relatively inactive. Also of note is AR3910 in the northeast, which historically gave a M9 flare when behind the northeast limb. This appears to be a relatively simple group, dominated by a main spot, with much smaller satellites. AR3912 emerging onto the southeast limb may be one region or two separate regions - for the time being it is classified as one region but this may change as it moves into a clearer viewing angle. The other regions are generally smaller and simpler. None of the active regions on the visible disc showed any notable growth or development. Assessment of sunspot regions is currently more difficult than usual with limited imagery due to the fact that SDO data is down.

During the forecast period new or returning regions are expected to rotate onto the visible disc, therefore the probabilities of significant flares may increase.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	40	40	40	40
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 4: Past 24 hours X-ray flares



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Solar Radiation Storms (High Energy Protons)

GOES-18 Proton flux is at background levels. There are a number of active regions currently on the disc, with the largest of these situated in the southwestern quadrant, increasing their potential connectivity. However, despite being moderately sized, the regions remain magnetically simple, and relatively inactive, resulting in only a slight chance of observable high energy protons being ejected from any larger flare that does occur.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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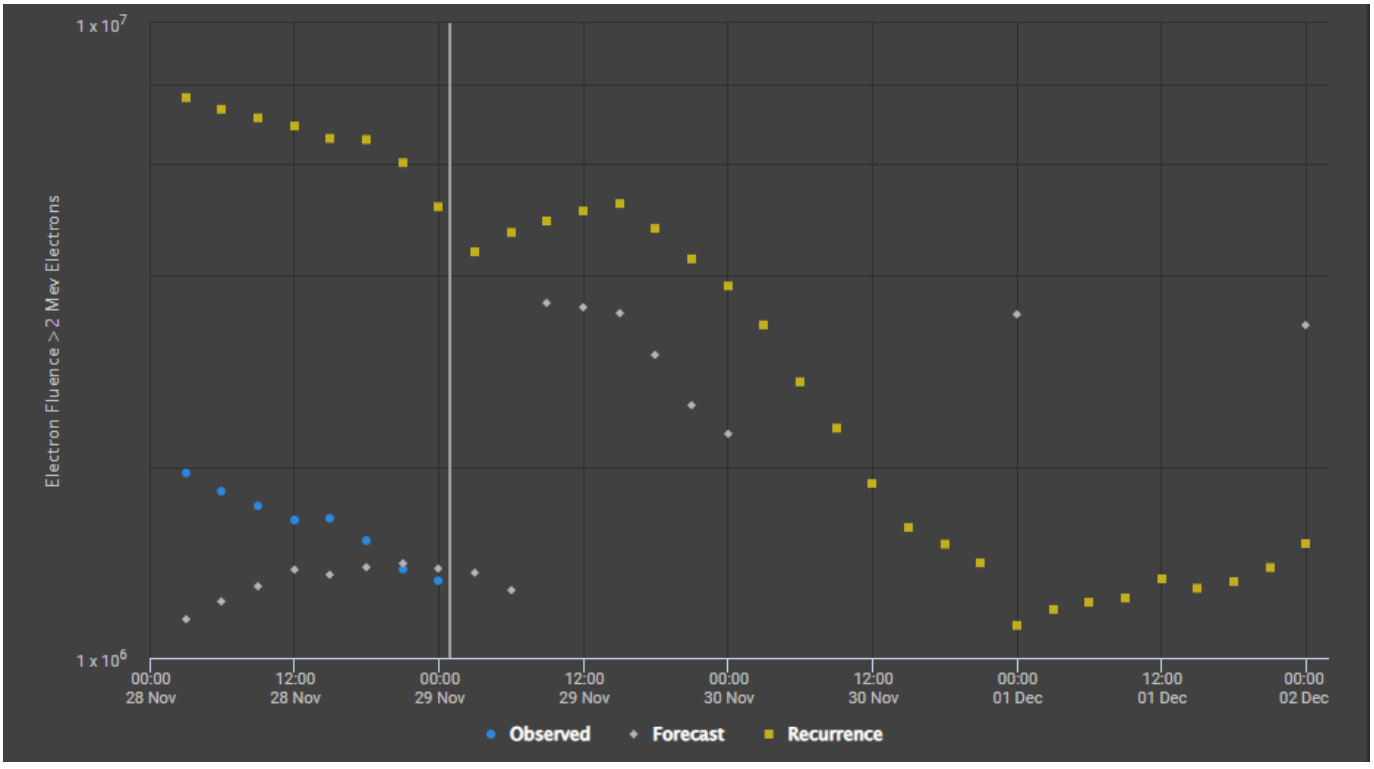
High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES-16 is at background levels, with no significant enhancements currently anticipated. due to the absence of any significant coronal hole features and associated high speed streams. The expected CME arrival today (29 Nov), and also potential glancing blow arrival on day 4 (2nd Dec) is not expected to have a notable impact on the observed flux levels at GEO.

The associated 24 hr fluence is expected to persist below Active, with MOSWOC REFM currently providing good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: Latest MOSWOC REFM model.



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